REMARKS

In the Office Action, the Examiner objected to FIG. 1 of the drawings, rejected claims 24-26 and 28-30 under 35 USC § 102(b), and rejected claims 1-18, 27 and 31-35 under 35 USC § 103(a). These rejections and objection are fully traversed below. In addition, the Examiner stated that claims 19-23 recite allowable subject matter.

Claims 24, 29 and 33 have been amended to further clarify the subject matter regarded as the invention. Claims 1-35 remain pending. Reconsideration of the application is respectfully requested based on the following remarks.

OBJECTION TO DRAWINGS

In the Office Action, the Examiner objected to FIG. 1 as lacking a "Prior Art" legend. As requested by the Examiner, a proposed drawing correction is submitted herewith seeking the Examiner's approval to add the legend "Prior Art" to Fig. 1. Accordingly, it is respectfully requested that the Examiner withdraw the objection to the drawings.

PATENTABILITY OF CLAIMS 1-35

In the Office Action, the Examiner rejected claims 24-26 and 28-30 under 35 USC § 102(b) as being anticipated by Engebretson et al., U.S. Patent No. 5,724,433; rejected claims 13-15, 27, 31-33 and 35 under 35 USC § 103(a) as being unpatentable over Engebretson et al.; and rejected claims 1-12, 16-18 and 34 under 35 USC § 103(a) as being unpatentable over Engebretson et al. in view of Schmidt, U.S. Patent No. 5,832,444. These rejections are fully traversed below.

The invention relates to improved approaches to filter and compress sound signals so as to not only achieve speech audibility and intelligibility at low levels but also preserve spectrum contrast at high levels. According to one aspect of the invention, gain amounts for different frequency bands can be individually constrained based on signal levels for the frequency bands. Hence, the gain amounts for each of the frequency bands may or may not be constrained depending on the corresponding signal levels. As a result, the most critical information for speech intelligibility, speech clarity, and speech quality can be made available to hearing impaired people over a wide range

of signal levels. The invention is particularly useful for hearing aids or other sound systems for the hearing impaired.

Engebretson et al. describes an adaptive compressive gain and level dependent spectral shaping circuit for a hearing aid. The circuitry includes, among other things, a gain circuit for each of a plurality of channels. "The gain circuit increases the gain of the channel amplifier when the channel output signal falls below the channel threshold level and decreases the gain of the channel amplifier when the channel output signal rises above the channel threshold level." See Abstract.

Schmidt describes an apparatus for dynamic range compression of audio signals. As stated at col. 9, lines 1-9,

> "[t]he compression system according to the present invention also reduces the spectral distortion present in many prior art multi-channel compression systems by providing a normalized level estimate for each bandwidth based on the level estimate of the original input signal. This provides a more accurate rendition of the original input signal and, when applied to hearing aid technologies, a more perceptively transparent compression system."

Claim 1 pertains to a method for processing sound signals for hearing impaired persons. Among other things, claim 1 recites "constraining the initial gain amount for each of the channel signals against gain amounts associated with at least one neighboring channel." Claim 1, lines 7-9. In Engebretson et al., various amplifiers and gain registers are utilized to amplify filtered input signals. With respect to Fig. 1 of Engebretson et al. it is stated:

> The output signal from amplifier 20 is connected to amplifier 16 for increasing the gain of amplifier 16 up to a predetermined limit when the output level from amplifier 16 falls below the threshold level stored in register 34 and for decreasing the gain of amplifier 16 when the output level from amplifier 16 rises above the threshold level stored in register 34.

Engebretson et al., col. 5, lines 6-12.

Further, as evident from Figs. 4-6, the filtered input signals from filters F1, F2, F3 and F4 are individually amplified without regard to input signals from other of the filters.

Accordingly, nothing in Engebretson et al. teaches or suggests constraining an initial gain amount for each of the channel signals against gain amounts associated with at least one neighboring channel. On page 8 of the Office Action, after acknowledging

the above-noted deficiency of Engebretson et al., the Examiner relies on Schmidt to makeup this deficiency of Engebretson et al. Specifically, the Examiner points to col. 4, lines 15-34 of Schmidt which discusses normalization of level estimates to reduce or eliminate spectral distortion.

In Schmidt, col. 4, lines 15-34 indicate that spectral distortion is reduced by providing a similar amount of actual compression across all bands. As described in Schmidt, the level estimate is essentially forced to a fixed (desired) level which is then used to retrieve the gain value from a lookup table for that channel. However, no across-channel information is utilized in this method. Specifically, Schmidt states at col. 4, lines 18-24:

> The solution utilized in this invention requires that the estimated levels for all frequency bands have a similar average amplitude. The control signal for each band is normalized to a target level using slow attack and release rates compared with the attack and release rates utilized in the temporal gain control.

Further, Schmidt states at col. 4, line 61 to col. 5, line 4:

> The function of the gain control 12 is to compress the input signal using slow time constants in order to maintain consistent long-term averaged levels and to effect compression without introducing any distortion artifacts. This practice is known conventionally as automatic gain control. Gain control 12 is provided with a control signal from processor 20 along line 18 according to the algorithm which is described herein. Processor 20 comprises programmed processor means in the form of a programmed digital computer which provides a control signal to gain control 12.

Moreover, Figs. 4A-4C of Schmidt depict an algorithm for implementing the audio signal compression via the controllers C_1 through C_{28}. Here, each frequency band is separately processed.

Consequently, with respect to claim 1, Schmidt also fails to teach or suggest "constraining the initial gain amount for each of the channel signals against gain amounts associated with at least one neighboring channel." Since Schmidt separately processes and produces gain values for each channel individually, there is no ability for Schmidt to constrain an initial gain amount for a particular channel in view of gain amounts associated with at least one neighboring channel. Therefore, it is submitted that claim 1 is patentably distinct from Engebretson et al. in view of Schmidt.

Claim 13 pertains to a method for amplifying sound signals in a multi-band sound processing system. The method operates to receive a signal level estimate for a channel signal corresponding to a particular frequency band of a sound signal. Then, a suitable gain amount is determined for the channel signal based on the signal level estimate. The suitable gain amount being determined is such that "when the signal level estimate has a high level, the suitable gain amount is constrained to preserve spectrum contrast across frequency bands, thereby preserving speech clarity and intelligibility." Claim 13, lines 7-9. Engebretson et al. does indicate that a gain circuit can increase or decrease the gain of a channel amplifier depending upon the signal level with reference to a threshold level so as to provide automatic gain control. However, such gain control is not performed to preserve spectrum contrast across frequency bands when the signal level estimate is high. Accordingly, it is submitted that claim 13 is patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Claim 28 pertains to a method for amplifying sound signals in a multi-band sound processing system. A signal processing unit operates to determine suitable gain amounts for each channel based on the signal level estimate corresponding to each of the channels. "When the signal level estimate has a high level, the suitable gain is constrained to preserve spectrum contrast across frequency bands." Claim 28, lines 11-12. Claim 28 recites limitations somewhat similar to those recited in claim 13, although in system format. Therefore, it is submitted that claim 28 is also patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Claim 24 pertains to a method for amplifying sound signals in a multi-band sound processing system. Among other things, the method determines a suitable gain amount for the channel signal based on the signal level estimate. Additionally, claim 24 recites: "when the signal level estimate has a high level, the suitable gain amount is constrained to limit variation of gain difference across frequency bands, thereby preserving speech clarity and intelligibility, and wherein, when the signal level estimate does not have a high level, the suitable gain amount is not constrained." Claim 24, lines 7-11. Accordingly, as recited in claim 24, the suitable gain amount for a channel signal is constrained when the signal level estimate has a high level, but not when the signal level does not have a high level. Although Engebretson et al. does utilize an automatic gain control circuit to increase the gain when the output signal falls below a threshold level and to increase the gain when the output level is above the threshold level, such

gain control is distinct from constraining gain amounts and is not performed for the purpose of limiting the variation of gain difference across frequency bands, as is recited in claim 24. Accordingly, it is submitted that claim 24 is patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Claim 29 pertains to a system for amplifying sound signals in a multi-band sound processing system. The system of claim 29 is generally similar, although in system format, to the method of claim 24. Hence, for similar reasons to those noted above with respect to claim 24, it is submitted that claim 29 is also patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Claim 26 pertains to a system for processing sound signals for hearing impaired persons. The system, among other things, includes a signal processing unit that produces an initial gain amount for each of a plurality of channels, and then constrains the initial gain amounts "by combining the initial gain amount with other gain amounts associated with neighboring channels to produce constrained gain amounts" (claim 26, lines 9-12). As noted above with respect to claim 1, neither Engebretson et al. nor Schmidt operate to constrain gain amounts with reference to other gain amounts associated with neighboring channels. Accordingly, it is submitted that claim 26 is patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Claim 30 pertains to a hearing aid device that includes signal processing circuitry that determines suitable gain amounts for channel signals. Among other things, claim 30 recites "when the signal level estimate has a high level, the corresponding suitable gain amount is constrained against gain amounts associated with one or more other channel signals." Hence, for reasons similar to those noted above with respect to claim 26, neither Engebretson et al. nor Schmidt teach or suggest determining or constraining gain amounts in view of gain amounts associated with one or more other channel signals. Accordingly, it is submitted that claim 30 is patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Claim 33 pertains to a computer readable medium that includes computer program code for processing sound signals. The computer program code recited in claim 33 is associated with operations similar to those recited in claim 1. Hence, for reasons similar to those noted above with respect to claim 1, it is submitted that claim 33 is also patentably distinct from Engebretson et al., alone or in combination with Schmidt.

Based on the foregoing, it is submitted that claims 1, 13, 24, 26, 28, 29, 30 and 33 are patentably distinct from Engebretson et al., alone or in combination Schmidt. In addition, it is submitted that dependent claims 2-12, 14-23, 25, 27, 31, 32, 34 and 35 are also patentably distinct for at least the same reasons as their corresponding independent claim. The additional limitations recited in the independent claims or the dependent claims are not further discussed as the above-discussed limitations are clearly sufficient to distinguish the claimed invention from Engebretson et al. and/or Schmidt. Thus, it is respectfully requested that the Examiner withdraw the rejections under 35 USC §§ 102(b), 103(a).

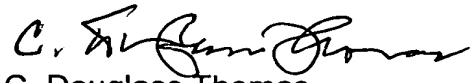
SUMMARY

It is submitted that Engebretson et al., alone or in combination with Schmidt, fails to teach or suggest features of the claimed invention. Therefore, it is submitted that claims 1-35 are patentably distinct from Engebretson et al. alone or in combination with Schmidt. Reconsideration of the application and an early Notice of Allowance are earnestly solicited.

If there are any issues remaining which the Examiner believes could be resolved through either a Supplemental Response or an Examiner's Amendment, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Applicants hereby petition for an extension of time which may be required to maintain the pendency of this case, and any required fee for such extension or any further fee required in connection with the filing of this Amendment is to be charged to Deposit Account No. 50-0388 (Order No. AUD1P008).

Respectfully submitted,
BEYER WEAVER & THOMAS, LLP



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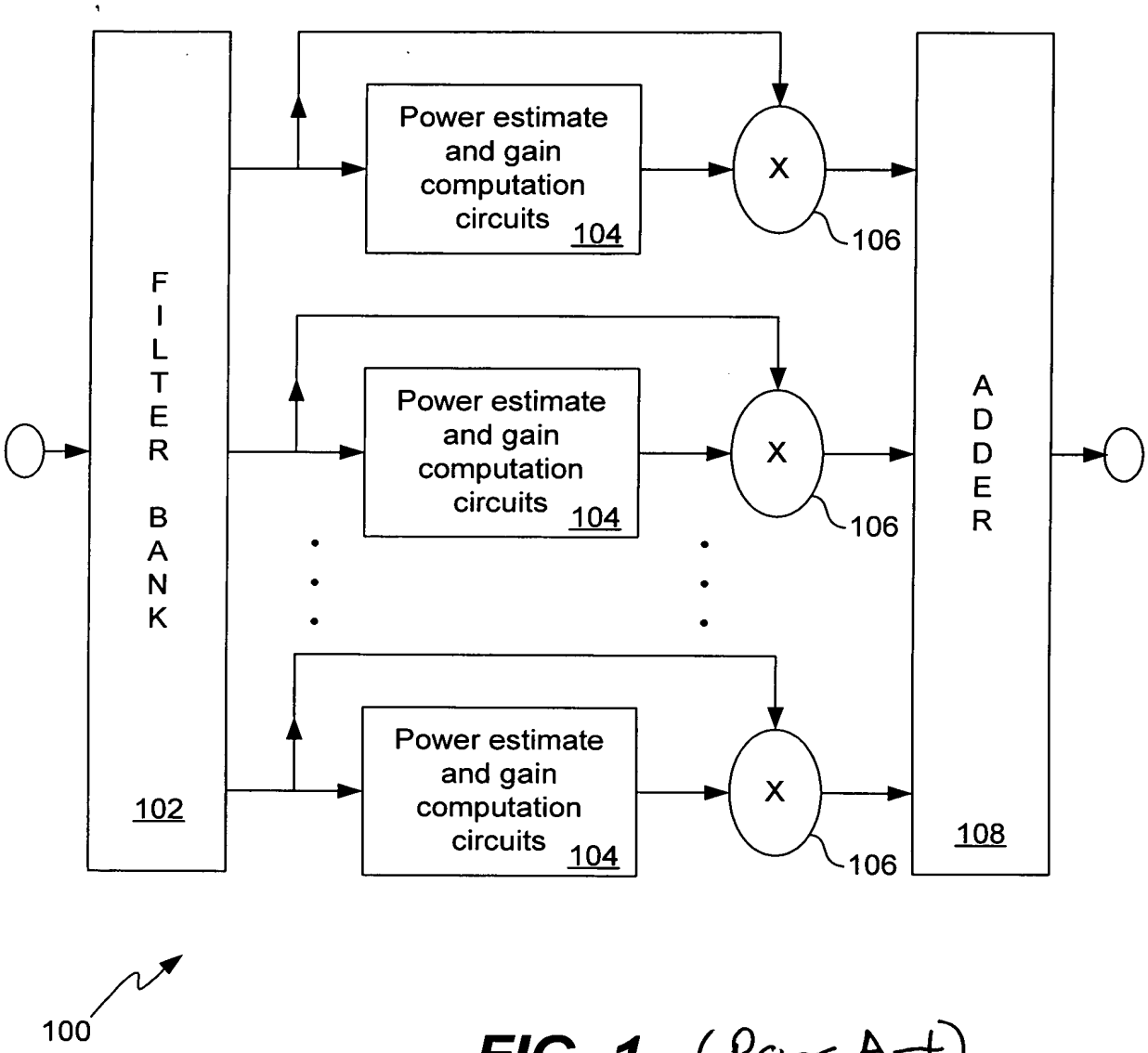

FIG. 1 (Prior Art)